

G.5

APPENDIX G**Process: Electroless Copper****Supplier #1**

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Cleaner/Conditioner	64.7	75.3	A	6	\$25.45/gal	\$98.79	\$114.98
Microetch	64.3	75.3	B	13.8 g/l	\$2.57/lb	\$50.27	\$58.87
			C	2.5	7.62/gal		
			D	18.5	\$1.60/gal		
Predip	49.8	75.3	E	31.725 g/l	\$1.31/lb	\$14.65	\$22.15
			F	1.5	\$2.00/gal		
Catalyst	138.5	75.3	G	4	\$391.80/gal	\$2,180.53	\$1,185.52
			H	0.176 g/l	\$1.31/lb		
			I	3.5	\$2.00/gal		
Accelerator	79.5	75.3	J	20	\$18.10/gal	\$287.79	\$272.59
Electroless Copper	185	75.3	K	7	\$27.60/gal	\$617.92	\$251.51
			L	8.5	\$16.45/gal		
			M	0.22	\$4.50/gal		
Neutralizer	57	75.3	N	100	\$1.60/gal	\$91.20	\$120.48
Anti-Tarnish	38.6	75.3	O	0.25	\$39.00/gal	\$3.76	\$7.33

Process: Electroless Copper**Supplier #2**

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Cleaner/Conditioner	64.7	75.3	A	6	\$25.45/gal	\$98.79	\$114.98
Microetch	64.3	75.3	B	13.8 g/l	\$2.57/lb	\$50.27	\$58.87
			C	2.5	7.62/gal		
			D	18.5	\$1.60/gal		
Predip	49.8	75.3	E	31.725 g/l	\$1.31/lb	\$14.65	\$22.15
			F	1.5	\$2.00/gal		
Catalyst	138.5	75.3	G	4	\$391.80/gal	\$2,180.53	\$1,185.52
			H	0.176 g/l	\$1.31/lb		
			I	3.5	\$2.00/gal		
Accelerator	79.5	75.3	J	20	\$18.10/gal	\$287.79	\$272.59
Electroless Copper	185	75.3	K	2.75	\$27.60/gal	\$623.45	\$253.76
			L	1.75	\$12.90/gal		
			M	14.5	\$16.45/gal		
Neutralizer	57	75.3	N	100	\$1.60/gal	\$91.20	\$120.48
Anti-Tarnish	38.6	75.3	O	0.25	\$39.00/gal	\$3.76	\$7.33

Process: Electroless Copper
Supplier #3

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Cleaner/Conditioner	64.7	75.3	A	10	\$36.68/gal	\$356.00	\$414.32
			B	5	\$28.78/gal		
			C	2.5	\$15.81/gal		
Microetch	64.3	75.3	D	9.8 g/l	\$2.62/lb	\$16.32	\$19.11
			E	2.5	\$1.60/gal		
Predip	49.8	75.3	F	75	\$5.39/gal	\$201.32	\$304.41
Activator/Palladium	57	75.3	G	1	\$497.71/gal	\$514.12	\$679.18
			H	75	\$5.39/gal		
Accelerator	79.5	75.3	I	8.96 g/l	\$497.71/lb	\$3,013.94	\$2,854.71
			J	1	\$77.71/gal		
Electroless Copper	185	75.3	K	4	\$11.51/gal	\$433.14	\$176.30
			L	10	\$15.44		
			M	0.2	\$19.36/gal		
			N	3	\$9.19/gal		
			O	0.5	\$4.50/gal		
Anti-Tarnish	38.6	75.3	P	1	\$28.26/gal	\$10.90	\$21.26

Process: Electroless Copper
Supplier #4

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Cleaner/Conditioner	64.7	75.3	A	12.5	\$10.30/gal	\$83.30	\$96.95
Microetch	64.3	75.3	B	5	\$12.32/gal	\$84.68	\$95.65
			C	3	\$13.81/gal		
			D	15	\$1.60/gal		
Predip	49.8	75.3	E	75	\$2.79/gal	\$104.21	\$157.57
Activator/Palladium	57	75.3	F	3.8	\$211.35/gal	\$638.35	\$843.29
			G	1	\$128.59/gal		
			H	579.5 g/l	\$0.39/lb		
Accelerator	79.5	75.3	I	5	\$16.47/gal	\$144.65	\$137.01
			J	15	\$6.64/gal		
Electroless Copper	185	75.3	K	5	\$9.57/gal	\$393.16	\$160.03
			L	1.5	\$9.22/gal		
			M	12	\$12.57/gal		
Acid Dip	78.8	75.3	N				
Anti-Tarnish	38.6	75.3	O	0.25	\$14.07	\$1.36	\$2.65

APPENDIX G**Process: Electroless Copper****Supplier #5**

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Cleaner/Conditioner	64.7	75.3	A	15	\$26.50/gal	\$257.18	\$299.31
Microetch	64.3	75.3	B	60 g/l	\$2.57/lb	\$83.59	\$97.89
			C	1	\$1.60/gal		
Predip	49.8	75.3	D	1165 g/l	\$1.59/gal	\$768.14	\$1,161.46
Palladium Catalyst	138.5	75.3	E	3	\$497/gal	\$2,280.00	\$1,239.60
			F	97	\$1.59/lb		
Electroless Copper	185	75.3	G	4.2	\$19.29/gal	\$1,834.31	\$746.61
			H	10	\$29.37/gal		
			I	12	\$51.40/gal		
Anti-Tarnish	38.6	75.3	J	2.5	\$20.50/gal	\$21.63	\$42.20
			K	3	\$1.60/gal		

Process: Electroless Copper**Supplier #6**

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Cleaner/Conditioner	64.7	75.3	A	0.5	\$22.70/gal	\$77.87	\$90.63
			B	4	\$26.88/gal		
			C	2.5	\$0.594/g		
Predip	49.8	75.3	D	5	\$99.29/gal	\$247.22	\$373.81
Activator	57	75.3	E	25	\$147.5/gal	\$2,101.89	\$2,776.71
			F	0.5	\$0.0594/g		
Reducer	57	75.3	G	0.5	\$147.5/gal	\$42.03	\$55.52
			H	5 g/l	\$.795/lb		
Electroless Copper	185	75.3	I	1.4	No data		
			J	8	No data		
			K	0.15	No data		
			L	3	No data		

Process: Formaldehyde-Free Electroless Copper
Supplier #1

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Cleaner/Conditioner	No data	75.3	A	10	\$36.68/gal	No data	\$384.56
			B	5	\$28.78/gal		
Microetch	No data	75.3	C	9.8 g/l	\$2.62/lb	No data	\$19.11
			D	2.5	\$1.60/gal		
Predip	No data	75.3	E	75	\$6.38/gal	No data	\$360.31
Activator	No data	75.3	F	1.5	\$497.71/gal	No data	\$562.17
			G	75	\$6.38/gal		
Accelerator	No data	75.3	H	8.96 g/l	\$497.71/gal	No data	\$2,854.70
			I	1	\$77.71/gal		
Electroless Copper	No data	75.3	J	11	\$92.96/gal	No data	\$1,633.84
			K	5.5	\$14.18/gal		
			L	32	\$24.99/gal		
			M	25 g/l	\$5.49/lb		
			N	15 g/l	\$12.43/lb		
Anti-Tarnish	No data	75.3	O	1	\$28.61/gal	No data	\$21.54

Process: Organic-Palladium
Supplier #1

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Cleaner	44	75.3	A	5	\$36.38/gal	\$104.95	\$180.45
			B	5	\$11.55/gal		
Microetch	64.3	75.3	C	75 g/l	\$16.20/gal	\$650.54	\$761.83
Predip	49.8	75.3	D	100	No data	No data	No data
Conductor	108	75.3	E	10	\$36.38/gal	\$534.6	\$372.74
			F	10	\$13.12/gal		
Post-Dip	45	75.3	G	20	\$17.42/gal	\$156.78	\$262.35
Acid Dip Bath	78.8	75.3	H	No data	No data	No data	No data
Conditioner	56	75.3	I	5	\$36.38/gal	\$133.58	\$180.45
			J	5	\$11.55/gal		

APPENDIX G**Process: Tin-Palladium****Supplier #1**

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Cleaner/Conditioner	64.7	75.3	A	25	\$22.90/gal	\$370.41	\$431.10
Microetch	64.3	75.3	B	149.8 g/l	\$3/lb	\$241.14	\$282.39
			C	0.5	\$1.60/gal		
Predip	49.8	75.3	D	100	\$12.75/gal	\$634.95	\$960.08
Activator	138.5	75.3	E	95	\$12.75/gal	\$6,871.33	\$3,735.82
			F	5	\$750/gal		
Accelerator	79.5	75.3	G	25	\$13.20/gal	\$724.44	\$686.17
			H	25	\$23.25/gal		
Acid Dip Bath	78.8	75.3	I	10	\$1.60/gal	\$12.61	\$12.05

Process: Tin-Palladium**Supplier #2**

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Conditioner	55.7	75.3	A	15	\$31.38/gal	\$292.13	\$394.93
			B	2.5	\$21.58/gal		
Predip	49.8	75.3	C	100	\$5.94/gal	\$295.18	\$447.28
Palladium Catalyst	138.5	75.3	D	92	\$5.94/gal	\$5,411.36	\$2,942.06
			E	8	\$420.80/gal		
Accelerator	79.5	75.3	F	20	\$68.75/gal	\$1,093.12	\$1,035.37
Enhancer	57	75.3	G	2	\$5.14/gal	\$25.81	\$34.10
			H	2	\$17.50/gal		
Stabilizer	57	75.3	I	2	\$17.50/gal	\$19.95	\$26.36
Microetch	64.3		J	7	\$25.79/gal	\$318.13	\$372.55
			K	2.5	\$104.29/gal		
			L	10	\$1.60/gal		
			M	5	\$7.50/gal		

Process: Tin-Palladium**Supplier #3**

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Conditioner	55.7	75.3	A	1	\$83.30/gal	\$46.40	\$62.73
Microetch	64.3	75.3	B	175 g/l	\$1.50/lb	\$140.55	\$164.59
Predip	49.8	75.3	C	100	\$2.95/gal	\$209.35	\$316.55
Catalyst	138.5	75.3	D	95	\$5.95/gal	\$6,634	\$3,607.00
			E	5	\$845/gal		
Accelerator	79.5	75.3	F	0.045 g/l	No data	No data	No data
			G	1.2			
Acid Stabilizer	78.8	75.3	H	10	\$1.60/gal	\$12.61	\$12.05

Process: Carbon
Supplier #1

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Cleaner	44	No data	A	5	\$90.43/gal	\$198.94	No data
Conditioner	55.7	No data	B	2.5	\$192.17/lb	\$267.60	No data
Carbon Black	128	No data	C	100	\$153.98/gal	\$19,709.44	No data
Microetch	64.3	No data	D	200 g/l	\$1.17/lb	\$126.03	No data
			E	1	\$1.60/gal		

Process: Graphite
Supplier #1

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Cleaner/Conditioner	64.7	No data	A	25	\$47.83/gal	\$773.66	No data
Graphite	36.5	No data	B	60	\$675/gal	\$14,782.50	No data
Fixer	57	No data	C	10	\$16.50/gal	\$94.05	No data
Microetch	64.3	No data	D	55	\$9.32/gal	\$331.66	No data
			E	2	\$1.60/gal		

Process: Conductive Polymer
Supplier #1

Bath	Volume in Bath (in gallons) Horizontal	Volume in Bath (in gallons) Vertical	Chemical Name	Percentage of Chemical in Bath	Cost of Chemicals	Total Cost of the Bath (Horizontal)	Total Cost of the Bath (Vertical)
Microetch	64.3	No data	A	2	\$1.60/gal	\$27.64	No data
		No data	B	7.5 Kg	\$3.41/Kg		No data
Cleaner/Conditioner	64.7	No data	C	10	\$21.90/gal	\$140.82	No data
Catalyst	138.5	No data	D	81.5	\$36.90/gal	\$4,183.90	No data
		No data	E	0.3	\$4.00/gal		No data
		No data	F	0.5	\$24.60/gal		No data
Conductive Polymer	26	No data	G	15	\$90.30/gal	\$460.70	No data
		No data	H	23	\$17.40/gal		No data
		No data	I	0.7	\$24.60/gal		No data

Summary average cost per bath

Process: Electroless Copper

Bath	Total Bath Cost (Conveyorized)	Replacement Frequency (Conveyorized)	Annual Cost (Conveyorized)	Total Bath Cost (Non-Conveyorized)	Replacement Frequency (Non-Conveyorized)	Annual Cost (Non-Conveyorized)
Cleaner/ Conditioner	\$161.99	10	\$1,619.90	\$188.53	9	\$1,696.77
Microetch	\$57.03	21	\$1,197.63	\$66.08	18	\$1,189.44
Predip	\$225.03	13	\$2,925.39	\$340.26	8	\$2,722.08
Catalyst	\$1,649.24	1	\$1,649.24	\$1,318.30	1	\$1,318.30
Accelerator	\$755.24	15	\$11,328.60	\$718.48	16	\$11,495.68
Electroless Copper	\$779.29	4	\$3,117.16	\$317.19	10	\$3,171.90
Neutralizer	\$91.20	6	\$547.20	\$120.48	6	\$722.88
Anti-Tarnish	\$9.41	28	\$263.48	\$16.15	13	\$209.95
Total			\$22,648.60			\$22,527.00

Process: Formaldehyde-Free Electroless Copper

Bath	Total Bath Cost (Conveyorized)	Replacement Frequency (Conveyorized)	Annual Cost (Conveyorized)	Total Bath Cost (Non-Conveyorized)	Replacement Frequency (Non-Conveyorized)	Annual Cost (Non-Conveyorized)
Cleaner/ Conditioner	NA	NA	NA	\$384.56	9	\$3,461.04
Microetch	NA	NA	NA	\$19.11	18	\$343.98
Predip	NA	NA	NA	\$360.31	8	\$2,882.48
Activator	NA	NA	NA	\$562.17	1	\$562.17
Accelerator	NA	NA	NA	\$2,854.70	16	\$45,675.20
Electroless Copper	NA	NA	NA	\$1,633.84	10	\$16,338.40
Anti-Tarnish	NA	NA	NA	\$21.54	14	\$301.56
Total						\$69,564.83

Process: Organic Palladium

Bath	Total Bath Cost (Conveyorized)	Replacement Frequency (Conveyorized)	Annual Cost (Conveyorized)	Total Bath Cost (Non-Conveyorized)	Replacement Frequency (Non-Conveyorized)	Annual Cost (Non-Conveyorized)
Cleaner	\$155.05	39	\$6,046.95	\$180.45	23	\$4,150.35
Microetch	\$650.54	21	\$13,661.34	\$761.83	18	\$13,714.74
Conditioner	\$133.58	25	\$3,339.50	\$180.45	18	\$3,248.10
Predip	-	21	-	-	14	-
Conductor	\$534.60	1	\$534.60	\$372.74	2	\$745.48
Post Dip	\$156.78	31	\$4,860.18	\$262.35	18	\$4,722.30
Acid Dip Bath	\$19.95	21	\$418.95	\$19.02	22	\$418.34
Total			\$28,861.52			\$26,999.31

*Acid Dip assumed to be similar in price to acid dip for tin palladium.

Process: Tin-Palladium

Bath	Total Bath Cost (Conveyorized)	Replacement Frequency (Conveyorized)	Annual Cost (Conveyorized)	Total Bath Cost (Non-Conveyorized)	Replacement Frequency (Non-Conveyorized)	Annual Cost (Non-Conveyorized)
Cleaner/ Conditioner	\$236.31	9	\$2,126.79	\$296.25	7	\$2,073.75
Microetch	\$233.27	21	\$4,898.67	\$273.18	18	\$4,917.24
Predip	\$380.04	15	\$5,700.60	\$574.61	10	\$5,746.10
Catalyst	\$6,305.56	1	\$6,305.56	\$3,428.29	1	\$3,428.29
Accelerator	\$908.78	7	\$6,361.46	\$860.77	7	\$6,025.39
Acid Dip Bath	\$15.06	7	\$105.42	\$16.82	8	\$134.56
Total			\$25,498.50			\$22,325.33

* Some processes included an enhancer bath that will not be included in analysis.

Process: Carbon

Bath	Total Bath Cost (Conveyorized)	Replacement Frequency (Conveyorized)	Annual Cost (Conveyorized)	Total Bath Cost (Non-Conveyorized)	Replacement Frequency (Non-Conveyorized)	Annual Cost (Non-Conveyorized)
Cleaner	\$198.94	26	\$5,172.44	NA	NA	NA
Conditioner	\$267.60	20	\$5,352.00	NA	NA	NA
Carbon Black ¹	\$19,709.44	1	\$19,709.44	NA	NA	NA
Microetch	\$126.03	21	\$2,646.63	NA	NA	NA
Total			\$32,880.51	NA	NA	NA

¹ Carbon had no bath replacements in the simulation, however, at least one bath out of two would more than likely have been replaced.

Process: Graphite

Bath	Total Bath Cost (Conveyorized)	Replacement Frequency (Conveyorized)	Annual Cost (Conveyorized)	Total Bath Cost (Non-Conveyorized)	Replacement Frequency (Non-Conveyorized)	Annual Cost (Non-Conveyorized)
Cleaner/Conditioner	\$773.66	11	\$8,510.26	NA	NA	NA
Graphite	\$14,782.50	3	\$44,347.50	NA	NA	NA
Fixer	\$94.05	NA	NA	NA	NA	NA
Microetch	\$331.66	21	\$6,964.86	NA	NA	NA
Total			\$59,822.62	NA	NA	NA

Process: Conductive Polymer¹

Bath	Total Bath Coat (Conveyorized)	Replacement Frequency (Conveyorized)	Annual Cost (Conveyorized)	Total Bath Cost (Non-Conveyorized)	Replacement Frequency (Non-Conveyorized)	Annual Cost (Non-Conveyorized)
Microetch		21		Not Avail.	NA	NA
Cleaner/Conditioner		13		Not Avail.	NA	NA
Catalyst		1		Not Avail.	NA	NA
Conductive Polymer		6		Not Avail.	NA	NA
Total						

¹ Cost data were not available for all chemical products when this analysis was completed. These costs will be included in the final analysis.